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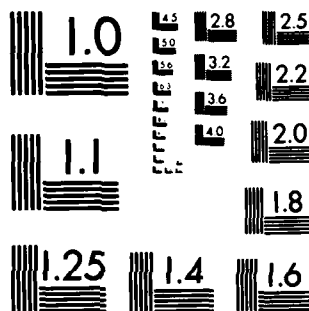
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sessions.

Test-retest reliabilities for these variables ranged from $r=.45$ to $r=.71$. As predicted, Type A characteristics were associated with greater task induced ANS reactivity (p less than .05). The study also examined specific ANS reactivity patterns such as task-induced heart rate changes. Subjects whose heart rates decreased 5 or more beats per minute on the cold pressor task, as contrasted with heart rate increasers (greater than equal plus 5 bpm), were five times more likely to self report they were "anxious, not sure why" and/or "worrying excessively over relatively trivial happenings" and were more than twice as likely to state that they frequently experience more than one of the listed symptoms.

Recommendations include continued work on redefining the concept of coronary prone behavior in terms of ANS reactivity rather than voice stylistics or self-report questionnaire, and the collection of ANS reactivity data plus medical history data from normals, hypertensives and angina patients.

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FINAL REPORT: AFOSR-81-0066

**THE DEVELOPMENT AND TESTING OF A PROTOCOL FOR
MEASURING AUTONOMIC REACTIVITY**

PRINCIPAL INVESTIGATOR:

CRAIG (A) DANIELS

UNIVERSITY OF HARTFORD



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ABSTRACT

Sixty male faculty and student volunteers were tested for autonomic nervous system (ANS) reactivity under relaxed, active task (Stroop color-word problems combined with a go/no go vigilance task) and passive task (cold pressor) conditions, and completed questionnaires on Type A characteristics and behaviors/symptoms often associated with stress. Physiological variables including frontalis muscle tension, skin temperature, heart rate, R-P interval and skin potential were measured over 30 second trial intervals for 5 trials (Relax1, Active Task, Relax2, Passive Task, Relax3) per session and 2 sessions.

Test-retest reliabilities for these variables ranged from $r=.45$ to $r=.71$. As predicted, Type A characteristics were associated with greater task induced ANS reactivity ($p<.05$). The study also examined specific ANS reactivity patterns such as task induced heart rate changes. Subjects whose heart rates decreased 5 or more beats per minute on the cold pressor task, as contrasted with heart rate increasers ($\geq +5$ bpm), were five times more likely to self report they were "anxious, not sure why" and/or "worrying excessively over relatively trivial happenings" and were more than twice as likely to state that they frequently experience more than one of the listed symptoms.

Recommendations include continued work on redefining the concept of coronary prone behavior in terms of ANS reactivity rather than voice stylistics or self-report questionnaire, and the collection of ANS reactivity data plus medical history data from normals, hypertensives and angina patients.

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FINAL REPORT: AFOSR-81-0066

THE DEVELOPMENT AND TESTING OF A PROTOCOL FOR
MEASURING AUTONOMIC REACTIVITY

Principal Investigator: Craig E. Daniels, University of Hartford

BACKGROUND AND RESEARCH GOALS

The major cause of death in the United States for some years has been coronary disease. A 1979 U.S. Air Force report estimated that one-third of the cardiovascular incidents to active duty personnel result in death or disability, that each death or disability to a flyer costs approximately \$495,000 and that the total direct costs of cardiovascular disease to the Air Force are approximately \$64 million per year.¹

Traditionally, a number of risk factors have been associated with cardiovascular disease (e.g. age, smoking, cholesterol level; however, since the early 1960's there has been continually increasing evidence which emphasizes the relationships between the way individuals respond to potentially stressful situations ("coronary prone behavior") and the development of atherosclerosis and myocardial infarction.

Typically, this behavior is characterized as:

- (1) an overdeveloped sense of time urgency.
- (2) excessive desire to control the environment.
- (3) a highly developed need for competitive achievement striving.
- (4) aggression or hostility.

⁽¹⁾ Petersen, C.C., Ravindran, A. et.al. Modeling and Analysis in Support of the Heart (Health Evaluation and Risk Tabulation) Program. USAF School of Aerospace Medicine Technical Report No. 8153-53-1287, 1979.

The result is that these individuals perceive their environment primarily in terms of challenges and frustrations and hyper-respond to these stressors. The precise psychophysiological mechanisms underlying these relationships are at present poorly understood; however, a major component appears to be situational hyper-reactivity or hyper-lability of the autonomic nervous system.2.3.4.5.6

Since autonomic reactivity is assumed to be a major mechanism linking coronary prone behavior and cardiovascular pathology, it seems logical to REDEFINE the measurement of coronary prone behavior by systematically investigating the individual differences in autonomic reactivity rather than refining voice stylistics and mannerisms which is the basis of the Structured Interview or attempting to increase self awareness and honesty of self reporting which is implicit in the Jenkins Activity Survey.

PROJECT OBJECTIVES

The project objectives are:

- (1) to determine whether the proposed protocol reliably discriminates among normal subjects on the basis of their autonomic nervous system (ANS) reactivity.

(2) Herd, J.A. Physiological correlates of coronary prone behavior. In T.M. Deambroski et. al. (eds.) Coronary Prone Behavior. New York: Springer, 1978, 129-136.

(3) Williams, R.B., Jr. Psychophysiological processes, the coronary prone behavior pattern, and coronary heart disease. In T.M. Deambroski et al. (eds.) Coronary Prone Behavior. New York: Springer, 1978, 141-146.

(4) Glass, D.C. Stress, behavior patterns, and coronary disease. American Scientist, 1977, 65(2), 177-187.

(5) Raab, W. Correlated cardiovascular adrenergic and adrenocortical response to sensory and mental annoyances in man: a potential accessory cardiac risk factor. Psychosomatic Medicine, 1968, 30, 889.

(6) Martson, L.M. Behavioural prevention of ischemic heart disease. Canadian Medical Association Journal, 1978, 119(6), 599-604.

- (2) to determine whether ANS response patterns are related to Type A coronary prone behavior as measured by questionnaire.

RESEARCH DESIGN

Subjects - One hundred testing sessions were conducted using 60 male students, faculty and staff volunteers. Subjects were paid \$4.00 per session for participation in the study.

Protocol - At the beginning of the first session each subject was checked for color blindness with a series of slides similar to those used in the study. The equipment was then demonstrated, the protocol explained in detail, and any questions answered. At this point the subject was seated in the test chair (a comfortable lounge chair), given a copy of the Informed Consent Form, asked to read the form carefully, ask questions if there were any points he did not understand, and then sign the form (see Appendix).

The Principal Investigator (PI) and his assistant then attached and tested the required sensors (see Variables below). During this time the PI and assistant engaged the subject in idle conversation to relax him and make him feel comfortable in the testing situation.

The room was then darkened so that it was dimly lit by natural light from behind and to the right of the subject. The subject was asked to sit back, close his eyes and relax while the sensor placement/contact was checked and a set of relaxed baseline readings (Relax1) was obtained. Sensors were adjusted or reapplied when necessary (approximately 5% of the time) and a

set of readings was taken over a 30 second period of time. During this and subsequent relaxation periods, if after 15-20 seconds the muscle tension, skin temperature or heart rate were either consistently increasing/decreasing, or highly labile, the readings were aborted and the 30 second recording period restarted. Again, if after 15-20 seconds the readings were still continuously changing, the recording was aborted and restarted a second and if necessary a third time. This procedure largely eliminated trends during the relaxation periods by allowing the variables to stabilize.

Following the recording of the initial baseline measures, a set of headphones was placed on the subject and the active dual task (modified Stroop Color Word problems combined with a go/no go vigilance task; see Tasks below) was explained. This explanation included a series of practice trials and a demonstration of the 100db sound. A 30 second set of measurements was obtained for each subject beginning with the tenth slide in the series.

At the completion of the active task trial, the headphones were removed and the subject was asked to sit back, close his eyes, and relax while a second set of relaxed measurements was taken following the same recording procedures as with the initial relaxation procedures.

The research assistant then removed the subject's right shoe and sock, rolled up his right pant leg, and moved a container of ice water into position while the PI explained the passive task (cold pressor test). A 30 second set of measurements was taken beginning 30 seconds after the subject placed his right foot in

the container of ice water. A third set of relaxed readings was taken following this task.

The first 40 subjects tested were asked to return for a second session two week later. Second sessions were scheduled the same time of day and day of the week whenever possible. All subjects agreed to return and 39/40 actually returned for the second session; the one subject who failed to return for the second session was replaced by calling the 41st subject and scheduling a second testing session for him. The second session followed the same procedure as the first with the omission of the explanation of the study and demonstration of the equipment.

At the end of the second session (or the first if the subject was not scheduled for a second session) each subject was given a packet containing three brief questionnaires; Type A behaviors, physical symptoms/behaviors associated with stress, and happiness/optimism, plus a form to request a copy of the results of the study (see Appendix). Subjects were asked to complete these forms in a space adjacent to the testing area and return the completed forms to the departmental secretary at the end of the hall. On receipt of the completed forms the departmental secretary paid each subject for his participation in the study.

Tasks - The active task consisted of a combination of two separate tasks, modified Stroop color-word problems and a go/no-go vigilance task.

The Stroop color-word problems consisted of a series of 35mm slides with a color name printed vertically down the left side in letters of a different color (second color) against a colored

background (third color) followed by four color names printed horizontally in a horizontal row in a fourth color. These four horizontal color names were always the four colors discussed above; i.e. the color of the letters of the vertical word, the vertical word itself, the background color and the color of the letters of the horizontal words. These four colors varied from slide to slide but were always different. Two sets of instructions were alternated, namely:

- (1) What is the color of the letters of the vertical word?
- (2) What is the vertical word?

These questions were printed in black on white on 35mm slides and interspersed randomly among the color-word slides.

After extensive pilot testing, oral responses were employed rather than the keypad, which had been specifically built for the task, since oral responses reduced movement artifact while recording the physiological data compared to keypad responses. The use of oral responses also permitted sensor placement on the fingers of both hands.

Subjects responded orally to each slide in accordance with the last set of instructions (i.e. color of letters or vertical word). This response was the signal to advance the slide to the next one in the series. The instruction slides were left on the screen for four seconds and then automatically advanced.

At the same time subjects were responding to these slides, they were asked to attend to two small light fixtures fastened to the wall to the right and left of the area illuminated by the slides. Each fixture contained three lights mounted vertically, green over amber over red. During the first session subjects

were instructed to say "go" when the red light was lit, "stop" when the green light was lit and make no response when the amber light was lit. For the second session the instruction were "go" for red, "stop" for amber and no response for green. The side lights remained lit for three seconds.

Subjects were instructed that if they made two consecutive errors on the slides or in responding to the side lights (i.e. incorrect response, failure to respond, too slow a response) they would be signaled with a loud 100db tone to the left earphone. In reality, however, the only sound given any subject was during the demonstration/instruction period preceding the actual trial.

The passive task was a standard cold pressor test in which the subject put his right foot in a large bucket of ice water (water height was approximately 13 inches) and was asked to move as little as possible and to keep his foot in the water until the PI told him to take his foot out of the water. In 96% of the trials the subject kept his foot in the water for the time requested (60-70 seconds).

Variables - Cyborg's BioLab21 system was used to simultaneously measure seven physiological variables during the five trials (Relax1, Active Task, Relax2, Passive Task, Relax3) which constituted each testing session. Specifically:

- o muscle tension was measured in microvolts (0-10) using three electrode disposable sponge strips taped in the center of the forehead (considered a frontalis placement even though technically the electrodes are not over the frontalis muscles).

- o heart rate was measured using a photoplethysmograph sensor attached with micropore tape to the pad of the third finger of the right hand.
- o blood volume was also measured using a photoplethysmograph sensor attached to the right thumb.
- o skin temperature was measured with a thermister attached to the pad of the third finger of the left hand with micropore tape.
- o skin potential was measured in microvolts using a spring held hand clip containing three disc electrodes; the active electrode on the palmar surface of the hand and the two reference electrodes on the back of the hand.
- o R-P interval was measured in milli-seconds using a sensor array as follows; two electrical pickups attached to the dorsal surface of the middle of the left forearm, one electrical pickup from the dorsal surface of the middle of the right forearm, and a pressure sensor attached with a velcro cuff to the left radial artery pressure point.

RESULTS AND DISCUSSION

Test - Retest Reliability - Test-retest reliabilities for muscle tension, skin temperature, heart rate and R-P interval were quite high for physiological variables under the level of control employed in this study and although the testing room was in a sealed window climate controlled building with a constant room thermostat setting, the room temperature which is known to

affect these variables did vary with outside weather conditions. Also, this study was not designed to impose any control on subject behavior, diet or drug usage prior to their arrival at the testing session. Potential subjects, however, were excluded from the study if they took hypertensive medication, tranquilizers or other prescription drugs on a regular basis. Unfortunately, this restriction resulted in the exclusion of a number of faculty volunteers!

Although the majority of subjects tested a second time were tested at the same time of day and on the same day of the week, a minimum of two weeks after the first testing session, the second testing sessions took place near the end of the academic semester when student behavior tends to be more erratic. (Data collection was originally scheduled to begin during the second week of the academic semester to minimize this problem, however, equipment delivery delays and vendor provided software problems resulted in delaying the actual data collection from the beginning of the fall semester to the middle of the spring semester - see Comments section.)

Specifically, Pearson Product Moment Correlations for each trial and variable combination of Session 1 with Session 2 found:

- o mean muscle tension reliabilities were highest at the beginning of the sessions (Relax1, $r=.66$) and for the change ratio between Relax1 and the Active Task ($r=.54$). Standard deviation muscle tension reliabilities were highest in mid-session (Relax2, $r=.66$) and during the Passive Task ($r=.75$); a particularly interesting finding since the Passive Task

instruction are to sit with your foot in the ice water and move as little as possible.

- o mean skin temperature reliabilities were relatively consistent during all five trials averaging $r=.50$ and ranging from .49 to .52. Since skin temperature changes rather slowly; as expected, standard deviations of skin temperature were not as useful as trial means.
- o mean heart rate and mean R-P interval readings were also more useful than trial standard deviations. Mean heart rate reliabilities averaged $r=.47$ and were undoubtedly decreased by the extreme active task induced heart rate deceleration (an average drop of 20 beats per minute. See Tasks below for a further discussion of this phenomenon.
- o mean R-P interval reliabilities were highest during the passive task (cold pressor, $r=.45$) and during the final relaxation period ($r=.51$).
- o standard deviation skin potentials (since skin potential was measured around a zero mean, trial means were not calculated) were also highest on the passive task ($r=.71$).

Although some of the blood volume correlations were statistically significant at the .01 level many were substantially lower and blood volume as measured in the present study was not considered to possess sufficient reliability to be a useful predictor variable.

Task Effects - Both the dual active task and the passive cold pressor task proved excellent for producing subject involvement

and physiological change. Since these tasks require relatively little time and equipment to administer them, are easily standardized and produce very different response patterns, they appear to be ideal and both are highly recommended for inclusion in ANS reactivity test protocols. (See Conclusions and Recommendations for additional detail.) The active task produce the changes shown in Table 1 below.

Table 1
SESSION 1 TRIAL MEANS FOR RELAX1 & ACTIVE TASK

| <u>Variable</u> | <u>Relax1 (baseline)</u> | <u>Dual Active Task</u> |
|-----------------------|------------------------------|-----------------------------|
| muscle tension (mmv) | 2.25 | 5.56 |
| skin temperature (oF) | 83.2 | 81.2 |
| heart rate (bpm) | 71.5 | 50.8 |
| R-P interval (msec) | 366.0 | 350.1 |
| skin potential (mmv) | .01 | .11 |

All differences significant at $p < .01$.

During the active task, the average heart rate decreased slightly more than 19 beats per minute.

Not only did the cold pressor test produce a very different pattern but it also produced sub-patterns (e.g. heart rate increasers, decreasers, low reactors) whereas the active task produced a heart rate decrease in 57/60 subjects. See Table 2 for a summary of the task mean readings for each session.

The skin temperature and R-P interval data in Table 2 suggests that subjects were slightly more relaxed at the beginning of Session 2 as compared to the first session which is

Table 2

TRIAL MEANS OVER ALL SUBJECTS FOR RELAX1 (BASELINE), ACTIVE TASK
(STROOP/VIGILANCE) AND PASSIVE TASK (COLD PRESSOR)

| Variable | RELAX1(BASELINE) | | ACTIVE TASK | | PASSIVE TASK | |
|------------------|------------------|----------|-------------|----------|--------------|----------|
| | Session1 | Session2 | Session1 | Session2 | Session1 | Session2 |
| muscle tension | 2.25 | 2.23 | 5.6 | 5.8 | 3.9 | 3.3 |
| skin temperature | 83.2 | 85.3 | 81.7 | 84.7 | 81.2 | 84.4 |
| heart rate | 71.5 | 71.5 | 50.8 | 53.5 | 73.0 | 72.5 |
| R-P interval | 366.0 | 399.9 | 350.1 | 374.0 | 388.9 | 415.3 |
| skin potential | .01 | .01 | .12 | .14 | .05 | .04 |

Session1 values based on n=60; session2 values based on subset of n=40.

Tabled values are means of trial means except for skin potential which is a mean of trial standard deviations since trial means are zero.

logical since subjects knew exactly what to expect from the experience the second time. This greater relaxation carried through the session as can be seen by comparing Session 1 and Session 2 skin temperatures and R-P interval intervals across the five trials. Although skin temperature and R-P interval readings are consistently higher in Session 2 than Session 1 the pattern from baseline for both tasks remains the same. This increased relaxation is not apparent in muscle tension and skin potential since the baseline averages for these measures is near the level of background noise in Session 1. Average baseline heart rate was the same for both sessions, however, greater relaxation in Session 2 is suggested by the slightly reduced active task induced heart rate deceleration.

The most dramatic effect shown in Table 2 is the heart rate change in each session. During the active task, average heart rate measured over a 30 second trial decreased an average of 19.6 b.p.m. in the first session and slightly less in the second session. The slight average increase in passive task mean heart rate is somewhat misleading since it masks the three distinct sub-patterns discussed under the section Hyper/hypo-reactors & Reaction Patterns.

Type A - Type B Differences Type A - B differences were examined two ways:

- (1) persons scoring 3 or less on the Type AB Scale were designated Type B's (n=7/60 -- none of the sixty subjects scored a 4) and persons scoring 11 or higher Type A's (n=18/60). Type A's and Type B's were then compared using F tests.

(2) Pearson Product Moment Correlations were calculated for the entire population ($n=60$) using the raw Type AB Scale score with the physiological trial means and standard deviations.

Type A behavior is conceptualized as a reactive phenomenon, therefore, no relaxed state baseline (Relax1) differences were predicted. The present study supports this model since no significant differences between Type A's and Type B's were found on any of the variables under relaxed baseline conditions.

The long range goals of this research project are to REDEFINE the concept of coronary prone behavior in terms of autonomic reactivity rather than voice stylistics and mannerism (Structured Interview) or self report questionnaire (Jenkins Survey) since these assessment techniques are badly flawed by low inter-rater reliability and the twin assumptions of self awareness together with honesty in self reporting respectively. Therefore, low positive relations between ANS reactivity during the two tasks and Type A behavior as measured by a modification of the Jenkins Survey were predicted. The present study found that under active task conditions compared to baseline, Type A's displayed greater increases in muscle tension ($p<.01$) greater skin temperature lability ($p<.04$) and lower than baseline R-P time intervals (Type B's were actually higher than baseline). Similarly, correlations between Type AB score and changes from baseline were in the predicted direction. The more Type A characteristics a person acknowledged, the greater the task induced means: muscle tension ($r=.25$), skin temperature ($r=.35$), heart rate ($r=.28$), R-P interval ($r=.23$) and skin potential

($r=.40$) -- all significant at less than the .05 level.

Hyper/hypo-reactors & Reaction Patterns - Given adequate test-retest reliabilities and low relationships between self report Type A behaviors and task induced ANS reactivity, the next logical step is to examine hyperreactors and response patterns and, in future studies, to attempt to link specific patterns with symptomatology and disease.

For example, consider heart rate during the active task. In the present study, 57/60 subjects exhibited task induced heart rate deceleration while only 3/60 subjects exhibited heart rate increases. Of these three Increasers, two had unusually low baseline heart rates (47 and 56 beats per minute) but the third subject (#27) had a resting heart rate of 81. During the active task he exhibited the highest heart rate, the second highest skin temperature, the third highest skin potential and well below average muscle tension. One other subject (#14) exhibited a virtually identical hyperreactive pattern; extremely high heart rate, skin temperature and skin potential with well below average muscle tension and a third person (#54) exhibited the same pattern but with an average heart rate.

By contrast during the passive task, heart rate response can be divided in to three patterns:

| | |
|--|------|
| Increasers ($\geq +5$ bpm over baseline) | n=24 |
| Decreasers (≥ -5 bpm below baseline) | n=16 |
| Changes of < 5 bpm from baseline | n=20 |

As a group, Increasers did not differ significantly from Decreasers on any other physiological variable measured, however, they did differ on several items on a one page check

list of physical symptoms and behaviors described on the form and to subjects as "signals often associated with stress". This form was completed by subjects when they completed the Type A behaviors questionnaire (see Appendix). The instructions asked each subject to mark "O" if he experienced these signals occasionally and "F" if he experienced them frequently "during the last year"; otherwise leave the line in front of the item blank.

Nine percent (2/23) of the Increasers who answered both items indicated that they were either occasionally or frequently "anxious, not sure why" and/or "worrying excessively over relatively trivial happenings" whereas 47% (7/15) of the Decreasers marked one or both items "occasionally" or "frequently".

A tally of the "frequentlies" for the symptoms (the three column grouping at the bottom of the list of behaviors and symptoms) found that 61% (14/23) of the Increasers as compared with 27% (4/15) of the Decreasers indicated that they had NOT EXPERIENCED ANY of these symptoms "frequently" during the past year. At the other end of the continuum, 22% (5/23) of the Increasers and 47% (7/15) of the Decreasers statated that they experienced MORE THAN ONE SYMPTOM "FREQUENTLY".

COMMENTS

Variables - Blood pressure and salivation measurements were reluctantly dropped from the protocol during pilot work since they interferred with the recording of the other variables which could be recorded continuously both during and across trial periods without distracting the subject. Specifically, although

a sphygmomanometer has been used successfully by the PI in other studies monitoring fewer variables, in the present study, the inflation of the cuff interfered with the signals from the sensors attached to the same arm.

Salivation as measured by inserting three cotton swabs in the subjects mouth is theoretically feasible and is elegantly simple, however, it would appear to be more useful where only one measurement over a longer trial period is employed since inserting the swabs produces an initial reflex salivation response and several changes of swabs create habituation problems. In the present study (five 30 second trials), these problems were further compounded when it was decided to use oral responses during the active task; oral responses from subjects with mouths stuffed with cotton was less than ideal from both the subject's and PI's point of view. Salivation data, therefore, was not gathered during the main portion of the study and salivation is not recommended as a variable for future ANS protocol studies.

Equipment - Delivery of usable equipment proved to be a major problem in completing the project within the grant period. In spite of the fact that the additional data acquisition modules and sensors for Cyborg's BioLab System needed for the project were order 4 to 12 months PRIOR TO THE START of the grant, with delivery promised for no later than Spring 1981 (2-3 months into the grant period), the modules and sensors were actually received during late summer and fall 1981 (the end of the original grant period)!

In addition, when the equipment arrived, the PI found that

the new modules required additional software to obtain the desired analog inputs; a fact not noted in the equipment specifications, literature or in conversations with Cyborg's representatives. Although the vendor eventually provided this additional software and documentation (at no additional cost) the net effect was a several week delay. This delay was then compounded by the fact that the new software, developed by Cyborg, is not compatible with the older software developed by Cyborg. Previous software packages consist of series of menus which allow the user to design and run sessions and analyze the raw data, etc., whereas the new software consists of several Applesoft compatible commands for data acquisition. Therefore, after receipt of this new software the PI had to write code for an entirely new data acquisition and analysis protocol; more delay.

Finally, when the PI tested the new protocol, which incorporated these data acquisition commands, he found that although the commands do produce analog input from the module/sensor combination, there are apparently bugs in the machine language routines which underlie the new command language since the input generated by these commands contained erratic random errors. Cyborg's technical staff was contacted and furnished a disc copy of the PI's program code but was unable to correct these problems by winter 1981. Since these modules were not purchased with Air Force funds and there had already excessive delays caused by the equipment delivery, the PI decided it was not reasonable to further delay the completion of the project. Therefore, although considerable pilot work was

done on respiration and pulse amplitude, these variables were not included in the protocol.

The BioLab21 Data Acquisition System is a Cyborg modification of an Apple II+ microcomputer which the PI has found to be extremely reliable in this and previous studies, however, the company's new all purpose physiology modules which were available for the first time for this study were extremely disappointing and Company support for them is poor.

CONCLUSIONS AND RECOMMENDATIONS

The present study strongly supports the idea of continuing to develop a standard protocol for measuring autonomic reactivity and collecting data on the relationships between autonomic reactivity patterns measured by this protocol as modified below, and symptomatology and disease.

Specifically, it is recommended that:

- (1) any ANS reactivity protocol include both tasks that actively involve the subject in problem solving tasks that provide a passive mildly stressful experience.

- (a) The active task designed for the present study worked extremely well. Although the combined color-word/vigilance task is simple to explain, implement and standardize and the majority of subjects made incorrect responses. One additional refinement which I plan to incorporate in future studies that I believe makes the task more interesting and even more challenging is the substitution of two additional slide projectors for the side lights. The side slides will have

black backgrounds and a variety of silhouette figures in different colors (e.g. planes, people, birds). The instructions will be to "fire" at enemy targets and not to fire on friendlies or non-targets.

- (b) The cold pressor test which was used as the passive task was also excellent and is very strongly recommended. It is simple and effective! Filling a large container with crushed ice (better than cubes) to a depth of approximately 12 inches and then adding cold water to the top of the ice works the best. Instructions should EMPHASIZE keeping the foot in the container until told to remove it from the ice water. (Keep all electrical equipment/wires off the floor even if they are some distance away as one subject managed to tip over the container of ice water while removing his foot from the container thus creating a minor flood as several gallons of ice water rushed across the floor.)

(2) protocol variables include:

- o muscle tension - the frontalis placement worked well in the present study, and since muscle tension appears to be a good candidate for a predictor variable it is recommended that a second muscle tension reading be taken from the trapezius muscles.
- o skin temperature measured by a finger thermister

as in the present study.

- o heart rate; the photoplethysmograph sensor on the pad of the middle finger is easy to use and produced an excellent signal.
- o skin potential; a potentially very useful variable that has not been used very frequently. In the present study subjects tended to cluster in one of three patterns; no measurable reaction, generally low activity throughout and high electrical activity during tasks.
- o R-P interval; tentatively an interesting and useful variable, however, the sensor array used for the R-P interval combined with the above variables preempts using a sphygmomanometer to measure conventional blood pressure.
- o respiration rate - I recommend further consideration be given respiration as a protocol variable. The bi-metal strip spring sensor recommended by both Beckman and Cyborg and supplied by Beckman did not generate a satisfactory signal and was uncomfortable for subjects to wear since it had to be strapped much too tightly around the chest to generate any signal. These problems combined with software problems resulted in the elimination of respiration rate as a variable in the

present study.

(3) future studies examine the relationships between ANS reactivity and:

- (a) medical history data taken by interview with an emphasis on current behavior and symptoms.
- (b) subject followup after one and two years to obtain medical history updates
- (c) serum variables on a specimen drawn following the testing session. For a normal population a logical series of analyses would be the SMA12. Although the catecholamines are of considerable interest the problems associated with collecting, and rapid analysis or chilling of the specimen and the difficulty of the performing reliable catecholamine analyses suggest that at this point in the project they would not be the best choice.
- (d) data on hypertensives and angina outpatients.

APPENDIX

INFORMED CONSENT FORM

Development and Testing of a Protocol for Measuring Autonomic Reactivity

Principle Investigator: Craig E. Daniels, Ph.D.

The purpose of this project is to determine whether reactive autonomic profiles will reliably distinguish among normal males and whether there is any relationship between these profiles and scores on the Jenkins Activity Scale.

Participation in the project involves completing a questionnaire and one or two 30-minute testing sessions. During the testing sessions a series of physiological measurements (e.g., skin temperature, muscle tension, heart rate, etc.) will be recorded under relaxed conditions and while participants engage in two tasks. There is no pain or discomfort associated with the measurements; however, the tasks do involve the use of a loud noise and cold water which some participants may find unpleasant.

All data will be considered confidential and participants will be identified by anonymous code numbers in any presentation of the data.

All participants who so request will be sent a copy of the results at the completion of the study.

Each participant will be paid \$4.00 per session at the completion of his final testing session.

Any participant may, at any time, with complete freedom, cease to participate in the project and request that his data be excluded; however, in this case the \$4.00 per session participation fee will not be paid to him.

The project is funded by an Air Force Office of Scientific Research Contract.

I have read the above and I am willing to participate in the project.

Participant's signature

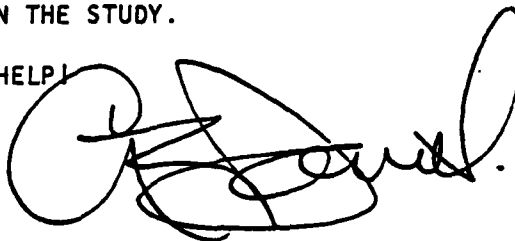
date

Witness' signature

date

PLEASE ANSWER THE FOLLOWING QUESTIONS AND THEN
TURN THE COMPLETED QUESTIONNAIRE IN TO EITHER
MRS. SIEGEL OR MRS. SILVERSTEIN DOWN THE HALL
IN DANA 301A AND COLLECT YOUR MONEY FOR
PARTICIPATING IN THE STUDY.

THANKS FOR YOU HELP!

A handwritten signature in black ink, appearing to be "David", written in a cursive style.

IF YOU WOULD LIKE TO RECEIVE A SUMMARY OF THE
PROJECT RESULTS, PLEASE COMPLETE A BLUE
SUMMARY REQUEST FORM AND TURN IT IN WITH
YOUR QUESTIONNAIRE.

ID _____

ALL INFORMATION WILL REMAIN CONFIDENTIAL AND
BE REFERRED TO ONLY BY ANONYMOUS ID NUMBER.

PLEASE ANSWER THE FOLLOWING QUESTIONS AS HONESTLY AS POSSIBLE.

THERE ARE NO RIGHT OR WRONG ANSWERS FOR ANY OF THE QUESTIONS!
RATHER THEY ARE GATHERING DATA ON BEHAVIOR AND ATTITUDES.

Thank you 

Circle either yes or no for each of the following 18 questions.

GENERALLY DO YOU

- | | | |
|--|-----|----|
| (1) tend to feel challenged to compete with other people when they "come on a little strong" in a social setting? | yes | no |
| (2) take pride in working best under pressure? | yes | no |
| (3) commonly explosively accent key words in your ordinary speech? | yes | no |
| (4) tend to speak rapidly and often speed up at the end of sentences? | yes | no |
| (5) typically think you can complete a task in less time than it actually takes you to complete it? | yes | no |
| (6) think of everyday life as filled mostly with problems and challenges as opposed to a rather predictable routine of events? | yes | no |
| (7) tend to say "uh huh...uh huh" or "yes..yes..yes," or nod your head up and down while listening to a person? | yes | no |
| (8) often finish sentences for other people or put words in their mouth? | yes | no |
| (9) become unduly annoyed when waiting in lines or behind slow cars? | yes | no |
| (10) think your closest friend or spouse would describe you as a hard driving, competitive type of person? | yes | no |
| (11) often set deadlines or quotas for your self at work or at home? | yes | no |
| (12) frequently think about or DO, two or more things at the same time? | yes | no |
| (13) usually feel vaguely guilty when you relax and do absolutely nothing? | yes | no |
| (14) typically schedule more than you can ever do in the time available? | yes | no |
| (15) believe that success in life is due in large part to the ability to get things done faster than most other people? | yes | no |
| (16) find yourself increasingly evaluating your own and others' activities in terms of "numbers?" | yes | no |
| (17) commonly clench your fist or jaw, pound one fist into the palm of your other hand or employ similar mannerisms? | yes | no |
| (18) Did you, when you were younger find that it was often hard to control your temper? | yes | no |

Circle the answer which best expresses how you feel about life in general.

1. SOONER OR LATER THINGS ALMOST ALWAYS WORK OUT WELL FOR ME
 - a. strongly agree
 - b. agree
 - c. neither agree or disagree
 - d. disagree
2. TAKING ALL THINGS TOGETHER, HOW WOULD YOU SAY THINGS ARE THESE DAYS--?
WOULD YOU SAY YOU'RE
 - a. very happy
 - b. pretty happy
 - c. not too happy
 - d. mostly unhappy
3. IN GENERAL, HOW SATISFYING DO YOU FIND THE WAY YOU'RE SPENDING YOUR
LIFE THESE DAYS? WOULD YOU CALL IT
 - a. completely satisfying
 - b. pretty satisfying
 - c. not very satisfying
 - d. mostly unsatisfying
4. I GENERALLY FEEL IN GOOD SPIRITS
 - a. almost always true
 - b. often true
 - c. sometimes true
 - d. seldom true
5. I FIND A GOOD DEAL OF HAPPINESS IN LIFE
 - a. almost always true
 - b. often true
 - c. sometimes true
 - d. seldom true

One of the long range goals of this project is to see if there are relationships between physical signals often associated with stress and physiological response patterns obtained in a lab setting.

Therefore, please indicate any of the following signals that you experienced either OCCASIONALLY or FREQUENTLY during the last year by writing

O = occasionally F = frequently
on the line in front of each signal which applies.

- | | |
|--|--|
| <input type="checkbox"/> anxious, not sure why | <input type="checkbox"/> opt for safe not necessarily best choice |
| <input type="checkbox"/> worrying excessively over relatively trivial happenings | <input type="checkbox"/> opt for high risk not necessarily best choice |
| <input type="checkbox"/> not especially concerned over important problems | <input type="checkbox"/> work overtime at office |
| <input type="checkbox"/> irritable or angry | <input type="checkbox"/> brought work home |
| <input type="checkbox"/> harping on failures and shortcomings of others or self | <input type="checkbox"/> obsessively occupied with work |
| <input type="checkbox"/> depressed | <input type="checkbox"/> wished were somewhere else |
| <input type="checkbox"/> feel helpless or unable to cope with life | <input type="checkbox"/> mistakes or minor accidents |
| <input type="checkbox"/> feel insecure or not appreciated | <input type="checkbox"/> drink wine or beer |
| <input type="checkbox"/> difficulty concentrating | <input type="checkbox"/> drink other alcoholic beverages |
| <input type="checkbox"/> miss appointments, deadlines; or | <input type="checkbox"/> smoke |
| <input type="checkbox"/> confuse dates, places, times | <input type="checkbox"/> use nonprescription drugs |
| <input type="checkbox"/> sharp mood swings | <input type="checkbox"/> use of tranquilizers or sleeping pills |
| <input type="checkbox"/> bored | <input type="checkbox"/> overeat |
| <input type="checkbox"/> difficulty making decisions | <input type="checkbox"/> loss of appetite |
| <input type="checkbox"/> sexual problems | |
| <input type="checkbox"/> sinus problems | <input type="checkbox"/> colitis |
| <input type="checkbox"/> hives or skin rashes | <input type="checkbox"/> ulcers |
| <input type="checkbox"/> cold sores/fever blisters | <input type="checkbox"/> menstrual cramps/distress |
| <input type="checkbox"/> low grade infections | <input type="checkbox"/> tire easily |
| <input type="checkbox"/> asthma attacks | <input type="checkbox"/> feel blah - no energy |
| <input type="checkbox"/> indigestion | <input type="checkbox"/> trouble falling asleep |
| <input type="checkbox"/> nausea | <input type="checkbox"/> bad dreams |
| <input type="checkbox"/> constipation | <input type="checkbox"/> poor sleep |
| <input type="checkbox"/> diarrhea | <input type="checkbox"/> wake earlier than usual |
| | <input type="checkbox"/> migraine headaches |
| | <input type="checkbox"/> high blood pressure |
| | <input type="checkbox"/> pounding/racing heartbeat |
| | <input type="checkbox"/> cold hands or feet |
| | <input type="checkbox"/> tension headaches |
| | <input type="checkbox"/> lower back pain |
| | <input type="checkbox"/> aching neck or shoulders |
| | <input type="checkbox"/> muscle pains in arms or legs |